

Testimony of Phyllis Wise, Provost

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Mr. Chairman and Members of the Subcommittee;

My name is Phyllis Wise. I am Provost and Vice President for Academic Affairs at the University of Washington and Professor of Physiology and Biophysics, Biology, and Obstetrics and Gynecology. My first research grant was from the National Science Foundation (NSF) in 1975. I'd like to thank the Congress for that support as it launched a long career of research in which I still engage. I would also like to thank you for the opportunity to appear before you today to provide a perspective from the University of Washington regarding the National Science Foundation (NSF), its important work and the prospects of making it even stronger in accomplishing its mission of knowledge generation and dissemination through fundamental research.

The reauthorization of the National Science Foundation (NSF) in 2007 presents an unprecedented opportunity to renew and reinvigorate the national commitment to excellence.

As a result of prior Congressional investments in the NSF and other federal science, we are now in an age of fantastic enabling technologies that blur the boundaries of disciplines and change the very nature of scientific inquiry from a descriptive endeavor to a predictive one.

This is a moment in the history of science when we have the tools that revolutionize how we collect, analyze, order, organize and retrieve data. We are in a time when imaging, simulation and robotics are part of the regular curriculum for the training of health professionals; where oceanographers consort with computer engineers and telecommunications experts to peer at the bottom of the ocean in order to learn about life in extreme environments so others can make predictions about the life in outer space; and where the living brain's operations can be observed, where emotion and even learning inside the brain can be detected and analyzed. It is wise that the Congress, in particular this committee and subcommittee, has elected to enhance an agenda that would spur discovery and encourage young Americans to get involved in these scientific frontiers.

These new technologies present challenges to existing structures and customs and it is the role of Universities and their partners in the federal government like the NSF to be thoughtful stewards of the human resources that drive this enterprise. Thirty five percent of the money NSF spends is for human capital, that rare commodity that generates new ideas, tests them, analyzes them and brings them to a stage of invention that can be transferred to the classroom as knowledge and to the commercial sector for development.

Universities have a duty to educate and prepare the students who come to their doors in a way that makes them responsible scientists and engineers. Those who are not destined for these careers also need to be scientifically literate. But our joint duty doesn't start or end with the students at our doors. Our nation needs to claim every resource, every talented student without regard to family income or social status or cultural background. Every kid needs a fair chance to become excited by the prospect of science, or engineering or mathematics as a career. Scientific and mathematics literacy must become a basic tenant of his/her education. No one questions whether a student must learn to read. The 21st Century literacy imperative must include mathematical and scientific literacy. The NSF and all of higher education need to embrace this goal and help to inform and guide the K-12 sector through teacher training and through continued research in the science of learning.

The NSF is unique among public agencies in having a mission to generate and value what is innovative. The process that has evolved at NSF for determining what constitutes a meritorious avenue of pursuit has been extraordinarily effective. Asking creative people to solve a defined problem is not the path to discovery. It may be the road to finding a creative solution to a specific problem but that is not innovation, that is problem solving. When a new way to ask questions or seek answers or combine materials or invent materials is pursued; when the human mind is engaged through curiosity to inquire about how something works or why it works the way it does, that is innovation. No other nation has had the courage to take that risk and put its confidence in human intellect to such a degree and no other has had the success of the U.S. in harvesting the fruit of that courageous confidence.

With more than 50 years of U.S. investment, the payoff to the nation has come in the form of new knowledge resulting in new products and processes that have, in turn, spawned a remarkable economic impact and an impact on health. Other nations are trying to emulate this model. The reward the U.S. has had for this investment has been priceless in terms of economic development, improvements in human welfare and abundance of inquisitive minds that continue to ask important questions. Clearly, there are important national needs like those articulated in the American Competitiveness Initiative (ACI) and they need to be honored in defining broad areas of inquiry. The NSF process for approaching those areas should not change. The merit based method of determining successful proposals is the most cost effective and most productive. We cannot anticipate what will be discovered or force a discovery. Science is at once methodical and unpredictable.

At our own institution for example, inquiry by UW scientists Jim Truman and Lynn Riddiford, who were passionately interested in understanding the biology of insect development, led to significant understanding of hormonal control of development. This research area has, in turn, had significant impact in the control of crop pests as well as mosquito populations in regions with raging malaria. The research was never intended to solve those problems. Rather, it was focused on trying to understand the most basic aspects of how animals control the sequence of events that surround development. And, who would have thought that the control of insect locomotion would affect the U.S. space program? Indeed, the control circuit of the six legs of walking stick insects is a form of distributed computing control that has since been used as a model for how six wheeled robots move. The Mars Rover is one of the best examples of systems inspired by insect neural systems. Similar concepts are emerging today on robots with

compliant legs and wings – Professors Thomas Daniel at the UW along with Michael Dickinson at Caltech and M.A.R. Full at UC Berkeley - are showing how studies of animal movement are inspiring new devices and designs. Biologists working in this area were not striving to create robots. Rather they were trying to understand the basic rules of nature.

Or, who would have thought that studies of adaptation, change, and the genetic basis of phenotypic variation would be used to solve complex mathematical problems? NSF has had a long and rich history of funding basic research in evolution and principles of this discipline have become embroiled in every aspect of our practical lives, from how we solve complex computational problems using genetic and evolution algorithms to how we use computers to develop better devices and machines.

Now, when our economic future is at stake, is the time to pick up on the wisdom of the National Academies of Science (NAS) study (*Rising Above the Gathering Storm*) and amp up the investment in our most precious raw material, human minds. The expressed intentions of this committee and its efforts to set new levels of funding for the National Science Foundation are critical to our nation's future.

In addition to responding to the questions the Chairman has raised regarding young investigators; our university relationships with industry; the balance between interdisciplinary and disciplinary research; and the process for integrating undergraduates in STEM education, I will offer some thoughts on graduate students and on ways to strengthen the noble partnership between the NSF and the nation's research universities.

1.) How do new investigators at your university fare in getting NSF research grants?

Does the university administration have any policies or mechanisms in place to assist your young faculty in securing funding or are those efforts strictly department-driven? Do you have any suggestions as to what NSF may do differently to improve funding success rates for new investigators?

Ensuring that our young new faculty members have a fair chance to succeed is of paramount importance to the University of Washington. As we compete with other top universities for the 'best and the brightest' young faculty, we make sizable investments in the form of recruitment packages. Start-up packages are provided with the understanding that setting up a new research program is expensive, and that such funds are necessary to give young faculty a chance at competing nationally for research dollars. It is not unusual for these packages to be several hundreds of thousands of dollars. But these funds are seldom enough to actually fund a research effort for the 2 or 3 years it takes to build a laboratory (if needed) and establish a productive research program. As a Tier 1 university, there is strong expectation that our new faculty develop productive, externally funded research programs within the first 4-5 years (promotion and tenure decisions are generally made in their 5th or 6th year). If external funding is not obtained in that time frame, promotion may be denied, and the faculty member may be forced to leave the UW. Not only is this a significant personal and career setback for the talented individual, but it represents a sizable loss of our investment.

Thus, it is imperative that we do everything that we can to help young investigators succeed.

In addition to start-up packages, we direct approximately \$2 million per year of royalty income (from UW inventions and other intellectual property) into an internal competitive grants program called the 'Royalty Research Fund'. Although not exclusively for junior faculty, it is heavily focused in that direction. Even with this program, only 25% of the applications we receive from junior faculty can be funded. But these funds provide a critical means for young faculty to gain experience in writing proposals, and also to obtain preliminary data that is often necessary to compete successfully for federal funding, including through the NSF.

How well do our junior faculty compete at NSF? Overall, faculty at the University of Washington do somewhat better than the national average in competing for NSF grants, but it is getting harder. For example, in FY2000, our faculty submitted 353 applications to NSF, and 154 were funded, for a success rate of 44% (the NSF average success rate was 33%). In 2006, our faculty submitted 460 grants (23% more than in 2000), and 158 were funded, for a success rate of 34% (the NSF average success rate in 2006 was 25%). Unfortunately, it is difficult to identify how many of these applications come from new Assistant Professors, and thus hard to say- with data - how well our new faculty do, compared to more 'seasoned' investigators. However, there is little doubt that, as 'paylines drop', junior faculty are disproportionately affected. As competition increases, the expectation of grant reviewers for a proven track record (e.g., publications) and substantial amounts of preliminary data continues to rise at a dramatic rate. This puts new investigators at a decided disadvantage in the competition. This is why it is essential that federal agencies establish funding mechanisms that are specifically directed at new investigators. In recognition of this problem, National Institutes of Health

(NIH) Director Elias Zerhouni recently announced a new “NIH Director's New Innovator Award” to support exceptionally creative new investigators who propose highly innovative approaches that have the potential to produce an unusually high impact.” The NSF is an active sponsor of the Presidential Early Career Award for Scientists and Engineers (PECASE), considered to be the highest national honor for investigators in the early stages of promising research careers. The University of Washington is proud that we have received three of these PECASE awards just in the past two years. This program recognizes the 'cream of the crop' of outstanding young research scientists across the country, and is an important source of support for these chosen few. But it does not solve the problem of how we maintain a vibrant cohort of young faculty that represent the future of academic research, but who require research funding in their earlier years to simply survive in an increasingly competitive environment.

I encourage NSF to take additional bold steps to ensure that promising junior faculty have the opportunity to succeed. I was pleased to learn that the committee is considering a new NSF program that addresses this issue, entitled “Small Grants for Exploratory Research” - a pilot program in which excellent proposals from new investigators that are not funded by the merit review committee can be funded for one year, at the discretion of the program officer. This is an innovative approach to addressing the challenge of new investigator funding. This approach does not circumvent the peer review process, yet will allow promising new investigators short term funding to collect critical proof of principle data that are increasingly required to compete successfully for a full NSF award. Providing NSF staff with the authority and resources to decide which new investigators do and do not get such pilot funding is a reasonable approach for streamlining this process. Of course, a key issue will be, “how far the money can go.”

Innovative new programs such as these are going to be increasingly important to ensure that we do not lose an entire generation of young faculty in academia. Increased support for the federal research agenda, especially NSF, is essential if our junior faculty are to establish successful research careers in academia.

2.) Please describe your university's relationship with local industries. How does the university administration help connect your faculty with local business entrepreneurs and leaders? Do you keep track of industry cost-share on NSF grants? Do you have any suggestions as to what NSF may do differently to facilitate university/industry partnerships at major research universities?

The Pacific Northwest has a culture of its own. Our traditional industries like aerospace, headlined by Boeing, and resource based industries like timber and logging no longer dominate our economy. They are complemented by a dazzling array of innovative high tech industries like Microsoft and Nintendo, iconoclastic retailers like Costco, Nordstrom and REI and unusual prototypes businesses like Starbucks and Amazon. There is an entrepreneurial spirit that may be attributable to the independence of the original settlers and a premium on thinking outside the box. Perhaps more unique but maybe more predictable, there is also a culture of collaboration which helps us to work across sectors. Businesses and the academy have always been closely tied in the Northwest and even regional governments collaborate. The UW medical school is the medical school for five states (Washington, Wyoming, Alaska, Montana and Idaho), who all got together almost four decades ago and decided to cooperate instead of compete. So they developed one top ranked Medical School to serve everyone.

The industry leaders of the region have a huge investment in the health of the universities. The universities, colleges and community colleges provide the next generation of thinkers, designers, and workers for these firms and provide an attractive enticement to employees they are trying to recruit. Reciprocally, the University sees this lively entrepreneurial environment as a recruitment tool for top faculty and students. There are many forums for university/industry engagement including participation of industry leaders on advisory boards across campus. Local business people also sit on visiting committees in almost all of the colleges and schools. There are numerous technology showcases such as the Northwest Entrepreneur Network as well as the Washington Biotechnology and Biomedical Association (WBBA) and the Washington Technology Center, which both host showcases to connect university researchers with local business leaders. The UW Office of Technology Transfer is active in the local business community and sponsors a program called LaunchPad where experts recruited from the business community mentor faculty on start up opportunities. The Seattle World Trade Center also serves as a facilitator for introductions on a case by case basis. The UW Office of Research has also set up an industry portal for easier access to its treasury of information.

The Board of Regents of the UW is appointed by the Governor and has always included major industry and community leaders in its number (e.g. we have had members of the Gates family on our board long before Bill Gates was in high school). Our relationship with local industries is healthy because we are viewed as part of the community. More than 200 companies have been spawned by the UW and many of those stayed right in the area. Our former students and

some current faculty are researchers at Microsoft and vice versa. Our President, Mark Emmert, and his administration work closely with community leaders through a number of different networks, the Puget Sound Partnership, the Washington Technology Alliance, the Washington Biomedical and Biotech Alliance and others.

We are fortunate to be in a community that cares. Our strongest connection with industry is through our students who join local work forces and continue to have ties to the campus. The UW administration works on a policy level to make connections with industry. The actual affiliations on the project level are conducted through faculty and an informal communication network. Our faculty are extremely entrepreneurial themselves and we have more than 1071 agreements for research with industry. Although we do not keep track of industry cost sharing on federal grants on a regular basis, we do track contributions when they are articulated as part of a grant proposal, as in the Engineering Research Center or Science Technology Center grants and others.

We feel the most effective partnership with industry and NSF is exemplified by our Engineering Research Center (ERC). In this case there is support from both industry and federal government and a sharing of the goals and objectives of the program. Issues are negotiated at the outset and there is a lively exchange and participation with all sectors. Through this type of mechanism, we are able to overcome the difficulties inherent in multi partner arrangements, namely, rights to information and data, control of direction of research and potential conflicts of interest which could interfere with reporting of research results. The ERC model is tried and true.

3.) What is the appropriate balance between funding for interdisciplinary and disciplinary research? What models or frameworks for interdisciplinary research seem to work best at your university? Is NSF doing a sufficient job of publicizing opportunities for funding of interdisciplinary proposals to your faculty?

In keeping with our culture of collaboration, the UW has a long history of interdisciplinary research. We like to think we are the great university we are today because our faculties have always talked within the UW and across the boundaries of disciplines. This may be due to the splendid isolation of our geography or our often soggy climate, but our various faculties have always talked a lot to each other rather than exclusively to their disciplinary counterparts at other places. There is a t-shirt about Seattle that summarizes the phenomena. "Seattle: Cool, Caffeinated and Connected".

This expectation of collaboration and synergy has resulted in more internal receptivity to unusual organizational arrangements and more flexible structures for creating new interdisciplinary departments and relationships. Typically, the actual projects are developed from the faculty rather than in response to external stimuli though we are always attuned to calls for proposals from sponsors, and the Provost's office often brings folks together to explore concepts. The UW Department of Bioengineering for example, is the oldest one in the country by a decade. We have just formed a Department of Global Health one of the first in the nation, which is a joint department between two Schools (Medicine and Public Health) and involves jointly appointed faculty from numerous other departments across the University.

There are not always federal funding counterparts to our new hybrid departments, so the challenge becomes one of characterizing the work in terms of the advances that will be made in each of the several disciplines. We are aware of the Congressional and NSF efforts to encourage funding for interdisciplinary work and we applaud it.

We also feel the federal experiments with multi agency joint projects are very important. For example, the University of Washington is home to the Pacific Northwest Center for Human Health and Oceans Sciences and along with three others is funded jointly with NSF and NIEHS (National Institute for Environmental Health and Safety) dollars. This is the first time these two agencies have joined forces and the Centers are tackling the new area of oceans and human health. One sample of the work is looking at gene environment interactions where both ocean scientists and human health researchers look at genetic diversity and environmental exposures or conditions to define response and mechanisms. The National Academies report entitled *Facilitating Interdisciplinary Research, 2005* (http://www.nap.edu/catalog.php?record_id=11153) gives a good roadmap for future interactions. Our project works well because both agencies have a commitment to basic science and that is proving to be key.

Putting transdisciplinary teams together to do BIG science is rewarding but the challenges administratively are formidable. Our embattled researchers suggest that the two very different grant mechanisms and cultural approaches should be recognized and more flexible administrative structures be improvised. The process for applying for projects which cross more than one agency are very cumbersome and discouraging. It would help to have a uniform

process in the federal government so if we must make duplicate proposals to several agencies for the same project, that at least we could use the same forms and some shared expectations.

As for the balance between interdisciplinary work and disciplinary research, it is a healthy tension. There is no question that the work of individuals advancing their unique disciplines forms the pillars of any interdisciplinary structure. We cannot forsake the individual investigator grant. It is also a way for young investigators to prove their value to an interdisciplinary team. Interdisciplinary work moves many disciplines forward and affords a new look at problems; a look with many different types of tools or skill sets but it will always be limited by the quality of the individuals represented. Because of the advent of new tools, like advanced computing, the borders between a lot of disciplines are disappearing or reconfiguring. This is an important time to use the new enabling technologies to explore and it probably warrants an explosion of interdisciplinary work. But each generation of investigators needs an opportunity to make a contribution at the disciplinary level and these grants must remain the core of the portfolio.

A possible mechanism to support junior researchers and create interdisciplinary ties would be to provide funds to supplement existing interdisciplinary projects for the purpose of adding a junior investigator, analogous to the way the NSF “Research Experience of Undergraduate” program funds opportunities for undergraduate research to existing projects.

4.) Please describe the process by which undergraduate science, technology, engineering and mathematics (STEM) curricula at your university are reviewed and updated as necessary in

response to shifting paradigms in these fields. What role does NSF play in this process? Do you have any suggestions as to what NSF may do differently to assist universities in maintaining world class undergraduate STEM education?

At the UW we have a commitment at the highest level to ensuring students who attend this research university reap the benefit of the research environment by participating in the research experience. The UW reports undergraduate engagement in research with faculty as one of our institutional accountability measures to our state legislature. This past academic year, we counted more than 4,000 student-quarters of intensive research (10 or more hours a week). Each Department at the University determines how it will incorporate experiential learning into its curriculum. In addition, we engage in a wide range of outreach programs to teachers and students in the community. Through funding from the Carnegie Corporation under their “Teachers for a New Era” initiative, science faculty in the College of Arts and Sciences are working with colleagues in the College of Education and local schools to develop a new Integrated Science undergraduate degree program that will be especially suitable for future secondary science teachers. Our existing science degree programs are too specialized for many future teachers, and in turn many teachers do not have a sufficient science background. This program will fill the gap.

Regarding the incorporation of new disciplinary paradigms in core curricula, all departments are reviewed every 10 years, more often if the review raises important issues. At the time of review, both the undergraduate and graduate curricula are examined by both internal faculty and outside experts in the field. While this is the primary formal process for curricula review,

most departments or programs review their curricula on a more frequent basis. Indeed, whenever a faculty member retires, or a new faculty member is hired, an opportunity is created to rethink how departmental or program curricular offerings should change to suit changes in the field. For most large departments, this happens on an almost yearly basis. NSF does not play a role in this process. Also, the fact that our faculties are actively engaged in research and teaching facilitates the transfer of research related discovery to the classroom independent of the formal structures for establishing curriculum.

The role and responsibility of NSF in STEM education and program evaluation is not clear. I would associate myself with the Association of American Universities (AAU) comments on the NSF strategic plan: *"...an important area for improvement in the plan is how NSF defines its role in this area. AAU would encourage NSF to define more precisely its specific role and responsibilities in the training and education of our nation's future scientists and engineers at all education levels. This includes clarifying how its role is both unique and complementary to that of other federal agencies such as the U.S. Department of Education. We feel that this plan provides an opportunity for the NSF to clearly define its role in education and that the draft plan as written does not take full advantage of that opportunity."*

One way for the NSF to ensure that undergraduate STEM curricula include leading edge research is to continue to support programs that fund this kind of work. For example, the NSF course, "Curriculum and Laboratory Improvement" (CCLI) offers funding to faculty who wish to develop innovative curriculum in STEM. One such grant at UW is to Professor Mari Ostendorf to improve a teaching lab for systems courses in Electrical Engineering. The NSF

“Science, Technology Engineering and Mathematics Talent Expansion Program” (STEP) provides funding to faculty and staff who wish to increase the number of undergraduate majors receiving STEM degrees. It is a program that promotes student professional development and curricular improvement by providing financial resources to institutions. Our college of Engineering has a collaborative STEP grant with Washington State University to work with four Washington state community colleges (Seattle Central, Highline, Columbia Basin and Yakima Valley) to increase the number of students transferring to the four year institutions to receive engineering degrees. The NSF grants process encourages, and often requires, a focus on educational mission. However, it would be especially useful if NSF were to provide grants to individual faculty that would provide them release time to update and improve undergraduate courses. Support for graduate Teaching Assistants, which are often paid at lower levels than graduate assistants, would also help to improve undergraduate education, both directly in terms of the courses they Teaching Assist (TA) for, and indirectly by providing future researchers teaching experience. Grants for updating and improving undergraduate laboratories would also be extremely helpful, as this is becoming increasingly expensive.

On a related STEM Ed issue, we do feel that the NSF Math and Science Partnerships (MSP) program is best positioned in the NSF where scientists feel welcome and in charge of the activity; where the science or math expert dominates the process. We have observed that the passion to pursue the disciplines is better transferred from those professing it. We also feel it is ironic that at a time when the administration is advocating increases in STEM education, the budget proposals for the NSF Education and Human Resources (EHR) budget have lagged behind the rest of the Foundation.

GRADUATE STUDENTS

I am remiss that my testimony has advanced this far with the peculiar absence of two key terms: graduate students and Post-doctoral fellows. To talk about research and leave out the energy that fuels the laboratories and teaching of science and engineering in the United States is a glaring error and I will remedy it. Neither group makes policy or is the Principal Investigator (PI) on grants but the success of any research policy or the performance of any laboratory is dependent on these warriors in the battle of discovery. The frustration of new faculty in their quest for grants is amplified as they have to find funds to support students. Recruitment and retention of faculty is highly linked to the support of graduate students. Nearly all of our new assistant professors say that the single most important issue they face is recruiting excellent graduate students. The most common model of support for graduate students, as Research Assistants on research grants, does not support enriching rotations and interdisciplinary research. We need to find ways to encourage that through auxiliary funding streams. Further, the NSF policy of five year non renewable graduate training grants moves money away from potential successful formulations of mentorship and interdisciplinary work. Long term support to broad inclusive graduate programs is needed. The programs that do exist, such as the IGERT (Interdisciplinary Graduate Education Research and Training) program, should be expanded.

THE PARTNERSHIP

The University of Washington shares the fundamental research mission and education mission of the NSF. In FY2006, UW researchers performed \$989.70 million in sponsored research,

most of it funded by the federal government. Of the federal total, NSF is the second largest federal contributor to the UW research enterprise and contributes approximately 10% to the total amount, and every directorate is represented. In every discipline we are partnered with the federal government. In FY 2006, UW received 587 grant awards from the NSF, totaling approximately \$94 million dollars. These awards were directed by 378 different UW faculty (Principal Investigators) and included an additional 432 as co-investigators, thus providing partial support for over 800 UW faculty researchers. In addition, NSF grants support hundreds of post doctoral fellows, graduate students, and undergraduate student researchers.

Because the Foundation and the University have mutual missions they have formed a partnership that serves the nation in important ways. We are appreciative of the work of this committee in particular in advancing the recommendations of the National Academies report *"Rising Above the Gathering Storm"*. The report raises national issues that must be addressed. It will require the achievement of delicate balances in order to accomplish our shared goals. These balances represent tensions on a variety of levels; between large multidisciplinary grants and grants to individual researchers; between seasoned and meritorious researchers and their junior brethren; between the forces that draw math, science and engineering graduates away from teaching leaving a disproportionate number of our K-12 teachers of math and science without strong disciplinary training in these critical fields. Balances between the involvement of industry in setting the research agenda and the need for unfettered exploration also need to be addressed. There are balances on the procedural level as well. These are expressed in the need of NSF program officers to stretch dollars, sometimes forcing funding decisions down to

the campus level and sometimes creating a dynamic which impairs the partnership and the purposes of peer review.

INFRASTRUCTURE

I am encouraged by the Chairman's intention to increase the investment in infrastructure. It is appropriate to review the investment in facilities and instrumentation as the Chairman recommends in HR 1067. I believe the “Major Research Instrumentation” (MRI) program should have an accelerated rate of increase, beyond the administration's contemplated increase in the size and number of individual awards. This is an age where the tools for science have become the science in almost every discipline. The manipulation of large complex databases is revolutionizing every field and the scramble for funds to pay for the development of the next generation of instrumentation for research and research training is enormous. It is appropriate not only that NSF sponsor and adjudicate the resources but also that there be a sufficient pool of funds to reflect the importance of instrumentation to success in science. The NSF initiative for “Cyber-enabled Discovery and Innovation” (CDI) is also one of the cross cutting programs that is essential in this environment.

The scope and breadth of the University of Washington research portfolio means we are involved significantly in many of the Major Research Equipment and Facilities Constructions (MREFC) efforts supported by the Foundation. In fact, we watch expectantly as the Ocean Observation Initiative moves through the MREFC python. The undersea laboratory component will be constructed out our front door, on the Juan de Fuca tectonic plate in the North East Pacific, and we have made considerable investments as an institution in the

development of this initiative. The science that is anticipated is sublime. It will involve oceanographers of course, but also marine biologists, seismologists, geologists, vulcanologists, fish scientists, astrobiologists, civil, mechanical and computer engineers, robotics specialists and computer scientists of all stripes and more. Real data in real time streaming from the bottom of the sea onto the world wide web to fuel hundreds of scientific minds and inspire generations of curious students; the scale of this project is hard to fathom, but the NSF and a phalanx of scientists from around the country will get it done with the help of Congress. Exploring the bottom of the sea is an extraordinary frontier for science and for future scientists who will be inspired by it at an early age.

Money is the issue. There are many extraordinary projects in the MREFC queue. Congress needs to stay committed to advancing the program despite the demands to spend money elsewhere. These are investments in the future and should not be viewed as simple expenditures or short term fixes.

POLICY AND PROCEDURAL ISSUES

There are some policy and procedural matters that I would like to raise with regard to some existing programs, particularly those that focus on building infrastructure, broaden participation, improve educational opportunities or support the development of multidisciplinary centers or multi institutional partnerships. In particular, we are concerned about the limitation on the number of proposals that may be submitted to over thirty of such NSF programs. When large institutions with strength in an area targeted by the program are allotted the same number of proposals as small institutions, or institutions without strength in

the program, it is inevitable that the program is not receiving all of the top proposals. An example of the problem is the IGERT (Interdisciplinary Graduate Education Research and Training) program. This is an excellent program, fostering novel interdisciplinary training programs and the development of new curricula to address pressing national problems. However, institutions such as the UW that have a strong track record in developing such programs are allowed the same number of submissions as other institutions that do not have the same capabilities. Currently, four proposals are allowed, which are reviewed at various Directorates and the best are chosen for submission of full proposals. However, the institutional limit for full proposals is only two, creating the difficult situation that at the UW, when more than two are picked for full proposals, the institution must withdraw a pre-proposal that was judged by peers to be highly meritorious. By this process, NSF is eliminating some of the strongest possible proposals. This is especially true if the pre-proposals that were selected are in different areas of research (e.g., different directorates).

In addition, at larger institutions priorities are normally set based on impact, which often scales with the numbers of faculty and/or the number of students. Therefore, traditionally smaller areas tend to not be as well represented as areas that are larger. An example is Geosciences, which at most institutions is one of these smaller areas. However, it is extremely important for emerging environmental problems. In general, for programs such as the IGERT program, these disciplines tend to not make the final cut of the top four which we would send as pre-proposals because of the scale. We recommend that NSF should limit the number of programs for which small (1-2) institutional limits are imposed to those that require especially onerous review, such as centers or other programs that require site visits. In cases in which limits are

imposed on pre-proposals, any pre-proposal chosen by peer review should be allowed to be submitted as a full proposal. If it is deemed important to impose total programmatic limits, then larger institutions should have a scaled limit, according to either total faculty size or NSF funding.

One other procedural matter presents public institutions with a particular problem. The issue of institutional matching funds was addressed in recent years as schools worked with the NSF director and the National Science Board (NSB) and even the Congress to stop the escalating bidding wars that went on in some NSF programs. Program directors attempting to husband their scarce resources would launch rivalries among highly ranked proposers to provide institutional matching funds to make the proposal more attractive to the officer. The NSF director issued directions to stop the practice, and the NSB stated that no matching was required. The practice has reemerged as the language stating that no match was required is being interpreted as not required but voluntary. State supported institutions cannot use public funds to support federal projects. We would like to see the practice of pitting PI's against their institution stopped.

Despite these difficulties, the NSF-University partnership is extraordinary. The Foundation has always been a model of administrative efficiency and manages an extraordinary portfolio of some 350 programs. Nearly half of the NSF workforce consists of scientists and engineers, all leaders in their fields who are among the 1,300 involved in the processing and management of research awards. Adequate funding for operations and award management, particularly in the information technology field is critical to the agency functioning as efficiently as possible.

While the overall research budget appears to be on an upward growth path, funding for operating expenses has remained essentially flat. As mentioned earlier, we have been submitting a lot more proposals and this is probably replicated by other like institutions. The collaborations with other schools and across agencies require a lot more human involvement at the Foundation level. NSF, like the Universities it serves, depends on top quality staff and that means favorable employment environments. We support increases for NSF infrastructure.

In closing, I would like to observe that science has moved from behind the scenes to the center of the stage in terms of helping our nation to stay competitive. We need to harness the human potential in every American kid and facilitate the efforts of those who do choose careers in research by streamlining the processes and making them more accessible. This is a huge task at a time when the nation's coffers are depleted but given American ingenuity, the National Science Foundation, the nation's research universities and some help from Congress, we can get it done. I appreciate the opportunity to present my views and I offer my help in any way to assist the Committee.